

## 5.8 Geology/Soils

Information contained in this section is summarized from the: 1) *Updated Geotechnical Investigation of the Dos Colinas Residential Development* prepared by Southern California Soil & Testing, Inc. (June 2, 2006); and, 2) *Geotechnical Investigation Dos Colinas Affordable Housing Site* prepared by Southern California Soil & Testing, Inc. (January 29, 2009). These documents are provided as Appendix G1 and Appendix G2, respectively, on the attached CD of Technical Appendices found on the back cover of this EIR.

### 5.8.1 Existing Conditions

#### 5.8.1.1 Continuing Care Retirement Community Site and RV Storage/Garden Area

##### A. Geology

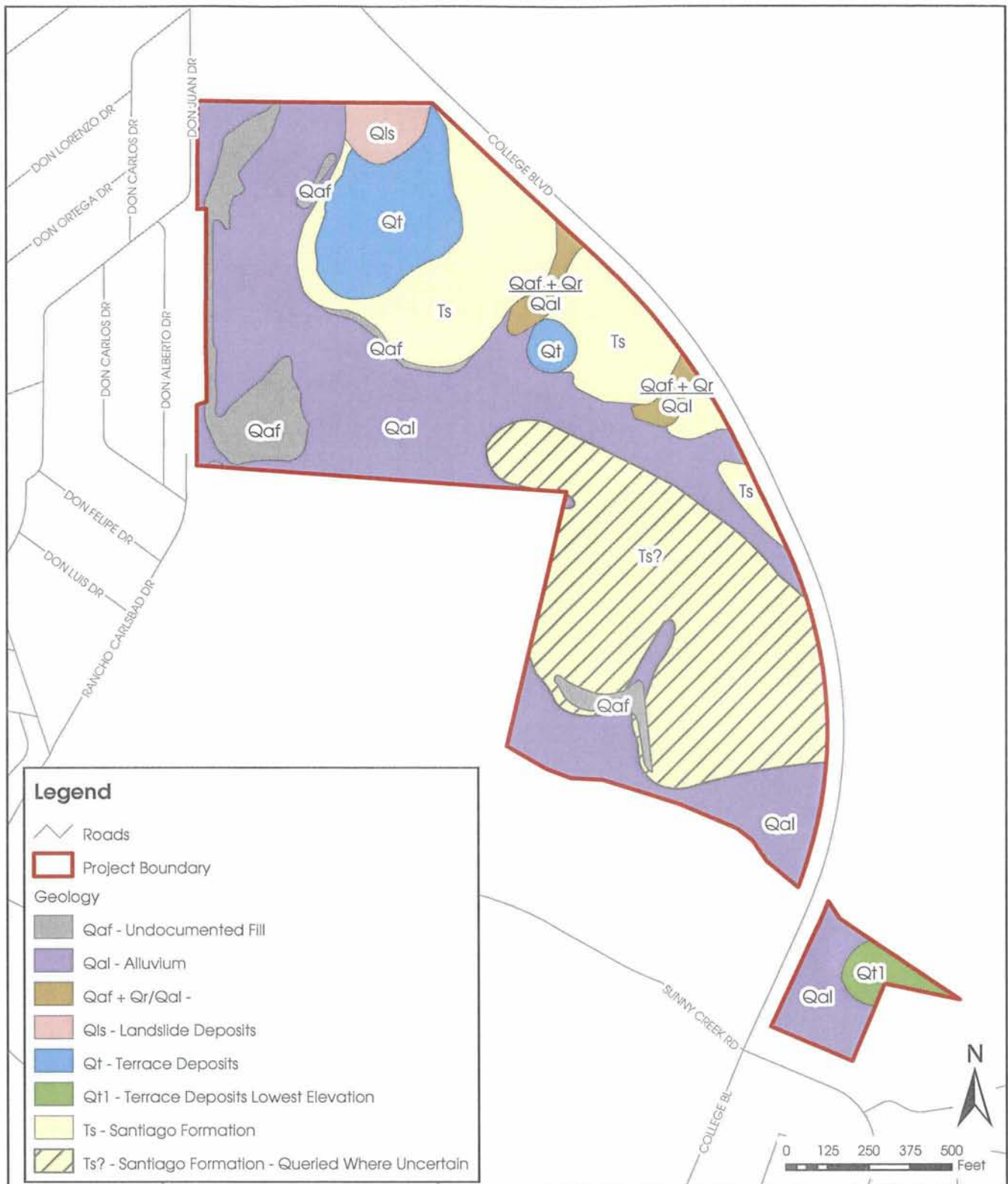
The CCRC site and RV storage/garden area is located within the coastal plains of the Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. The western portion of the Peninsular Ranges generally consists of Upper Cretaceous, Tertiary, and Quaternary-age sedimentary rocks.

The CCRC site and RV storage/garden area is underlain by the sedimentary layers of the Eocene-aged Santiago Formation. Human influences, recent weathering and erosion have produced landslide deposits, alluvium, residual soils, artificial fill, and Pleistocene-age terrace deposits. Figure 5.8-1 depicts the geologic units underlying the project site. The geologic units occurring within the CCRC site and RV storage/garden area are described below:

##### Geologic Units

**Alluvium (Qal):** Alluvial deposits are documented throughout the low-lying areas of the CCRC site, generally in the RV storage/garden area extending to depths in excess of 50 feet below the existing surface in some areas. In smaller drainage swales and tributaries, alluvial soils are estimated with depths ranging from a few feet to approximately 15 feet. The alluvium present at the CCRC site is generally dark brown to dark reddish brown, loose to medium dense, silty to clayey sand with occasional interbedded clay layers. Colluvial soils with a higher clay and silt content are likely interbedded with alluvial soils in the smaller drainages and near the base of the hills. Shallow groundwater was encountered in alluvial areas.

**Quaternary Terrace Deposits (Qt):** Quaternary terrace deposits overlie the Santiago Formation deposits in some of the higher elevations of the CCRC site. These deposits are generally reddish brown to brown to tan, medium dense to dense, silty clay and clayey sand with less common, interbedded sandy or clayey silt. Although these soils are considered easily erodible, they generally have a low potential for deep-seated slope instability.



SOURCE: Southern CA Soil & Testing, Inc., 1996; BRG Consulting, Inc., 2010

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## Dos Colinas EIR Geologic Units

FIGURE  
5.8-1

**Santiago Formation (Ts, Ts?):** The southern portion of the CCRC site and portions of the RV storage/garden area are underlain by sedimentary layers of the Eocene-age Santiago Formation. The most common deposits documented at the CCRC site are generally light gray to pale green in color, dense, with sandstone interbedded with sandy to clayey siltstone. Occasional beds of olive or dark-green claystone were also encountered.

The sedimentary deposits observed in subsurface explorations in the southeastern portion of the CCRC site appeared uncharacteristic of the Santiago Formation. Many of the observed deposits appear to be only moderately well consolidated, weakly cemented, or uncemented, and highly oxidized. It is probable that some of these deposits are late Tertiary sedimentary deposits or Quaternary terrace deposits rather than Eocene-age Santiago Formation deposits. None of the uncharacteristic Santiago Formation deposits are mapped as terrace deposits, but are instead annotated with a question mark (i.e. the “Santiago Formation?” is mapped on Figure 5.8-1 with the symbol “Ts?”) to indicate the uncertainty.

Also, a thick section of relatively weak claystone and siltstone was encountered. These relatively weak deposits will likely be exposed in portions of the 25 to 30-foot-high cut slope proposed to the north of proposed cottages 17 and 18 located in the central cluster of cottages.

## **Soils**

**Artificial Fill (Qaf, Qr):** Artificial fill is documented in several areas of the CCRC site, with the majority occurring in the RV storage/garden area. It appears to occur in thicknesses of three feet or less. Fill materials consisting primarily of end-dumped concrete rubble and other debris are present in two tributary drainages, as well as in limited quantities in other localized areas of the site. In addition, isolated areas of agricultural fill and fill associated with the existing golf course may be present.

**Residual Soils (not mapped):** Residual soils overlie the sedimentary deposits throughout the majority of the CCRC site. One to two feet of topsoil consist of brown to grayish-brown, fine clayey to silty sand that form the surficial layer throughout most of the site. The hilly areas of the site are underlain by topsoil that is generally underlain by one to two feet of subsoil comprised mainly of dark brown, sandy to silty clay.

### **Landslide Deposits (Qls):**

Landslide deposits underlie the extreme northeastern corner of the CCRC site. Features observed in a trench excavated during the geotechnical investigation confirmed the presence of a landslide. At this trench location, Santiago Formation is underlain by extremely well-cemented sandstone at the depth of about 12 feet. The lowermost 6 inches of the claystone exhibits extensive evidence of shearing. The very well cemented sandstone bed is laterally continuous, cropping out at the toe of the slope north of the site boundary.

### 5.8.1.2 Affordable Housing Site

#### A. Geology

The geologic subsurface investigation for the affordable housing site encountered fill and alluvium.

**Fill (not mapped):** The fill is comprised of loose silty sand that extends about 1 foot below the existing ground surface.

**Alluvium:** Alluvium underlies the fill and consists of interbedded, silty and clayey sand, well-graded sand with silt, and sandy clay.

#### B. Seismicity (CCRC Site, RV Storage/Garden Area, and Affordable Housing Site)

As is common in most of Southern California, the project is located within a seismically active region. There are a number of faults considered active in Southern California. These include, but are not limited to: the San Andreas fault, the San Jacinto fault, the Elsinore fault, the Coronado Bank fault zone and the Rose Canyon-Newport-Inglewood fault zone. Figure 5.8-2 depicts the location of regional active faults. No known active fault or potentially active faults are known to exist on, or in the immediate vicinity of the project site. The nearest known active fault is the Rose Canyon Fault, located approximately thirteen kilometers west of the project site. The potential for ground acceleration, or shaking, at the site is considered similar to the Southern California region.

Based on project site location, soil characteristics, and typical site development procedures, impacts resulting from tsunamis and seiches are not anticipated to occur onsite. Seismic hazards that may affect the site include ground shaking, surface rupture and soil cracking, and liquefaction. The seismic hazards affecting the site are discussed below.

##### **Ground Shaking**

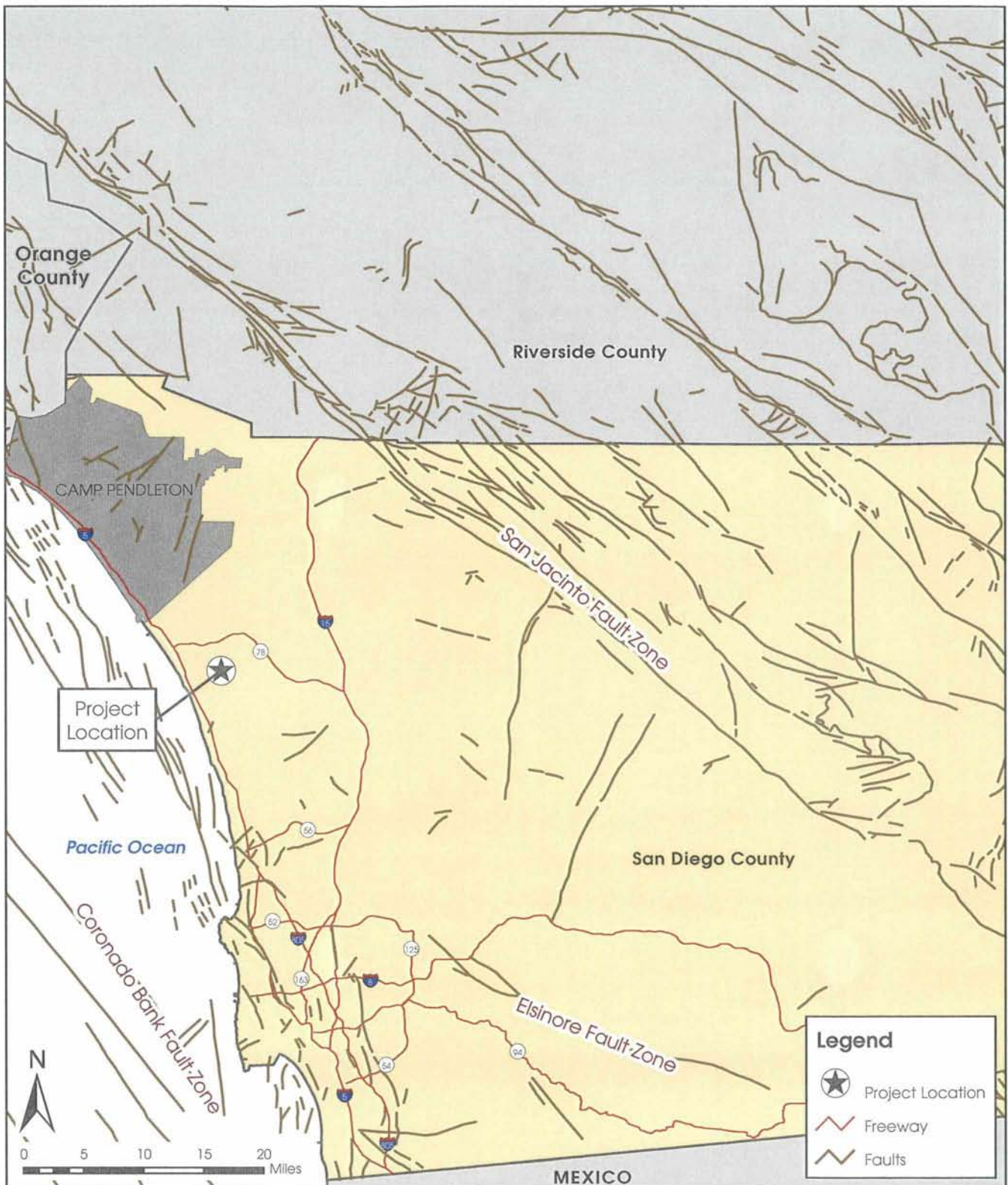
The geologic hazard most likely to impact the project site is ground shaking resulting from movement along a major active fault. Since the project site is relatively close in proximity of the Rose Canyon Fault Zone, the most significant ground shaking from one of the regional faults will most likely occur on the Rose Canyon Fault Zone. Ground shaking intensity ranges from slight to strong depending on factors such as earthquake magnitude, the distance to the epicenter, and soil profile.

##### **Surface Rupture and Soil Cracking**

Ground rupture generally occurs along pre-existing fault strands. The project site is not at risk to surface rupture since there is no evidence suggesting on-site faulting. However, there is a minimal risk of soil cracking resulting from distant seismic events.

##### **Liquefaction**

Liquefaction primarily occurs when saturated, loose, fine to medium-grained soils are shaken during an earthquake. The soils lose their strength and behave as a liquid. A primary factor controlling the potential



SOURCE: USGS, 2005; SanGIS, 2010; BRG Consulting, Inc., 2010

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Dos Colinas EIR

## Regional Fault Map

FIGURE  
5.8-2

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for liquefaction is groundwater depth. Relatively shallow groundwater was found in numerous borings in the low-lying alluvial areas, generally in the RV storage/garden area, along the northwest portion of the CCRC site. These portions may be subject to seismically induced liquefaction. However, the potentially liquefiable soils do not represent a significant impact, as they are located beyond the limits of the proposed CCRC site.

The underlying materials at the affordable housing site are considered to be liquefiable and two inches of total settlement could occur.

### **C. Landslides and Slope Stability**

Landslides occur when slopes become unstable and collapse. Landslides and slope instability may be caused by natural factors such as topography, precipitation, and soil types. Other hazards such as floods and earthquakes may also trigger such events. According to Landslide Hazard Identification Map No. 33 prepared by California Geologic Survey, the majority of the site is located within Landslide Hazard Area 3-1. Area 3 is considered susceptible to slope instability. The low-lying areas of the CCRC site are located within Landslide Hazard Area 2, which are only marginally susceptible to slope failure. The site is susceptible to landslides due to low strength characteristics of the claystone and siltstone portions of the Santiago Formation. During the geotechnical investigation, the presence of a landslide at the northeastern end of the CCRC site was confirmed.

### **D. Expansive Soils**

Expansive soils are primarily comprised of clay soils, which expand when the soil becomes saturated and shrink when dry. A large amount of the residual soils and portions of the Santiago Formation deposits are considered moderately to highly expansive.

### **E. Groundwater**

Southern California Soil and Testing, Inc. performed subsurface investigations in 1989 and 1998 (See Appendix IA, IB, IC of the *Updated Geotechnical Investigation of the Dos Colinas Residential Development [Appendix G1 of this EIR]*). These investigations consisted of 19 trenches and 4 borings. Groundwater was encountered in the low-lying alluvial areas, generally in the RV storage/garden area, along the northwest portion of the CCRC site ranging from 10 to 18 feet. No groundwater was encountered in the smaller tributary drainages. However, minor groundwater may occur within the alluvial deposits of the small drainages during the winter months.

Groundwater was also encountered on the affordable housing site at depths ranging from 13 to 14 feet below the existing surface.

### **F. Flood Hazard**

The majority of the low-lying alluvial areas of the project site are within a 100-year flood plain. (See EIR Section 5.12 Hydrology/Water Quality).

## 5.8.2 Threshold for Determining Significance

Appendix G of the CEQA Guidelines is used to provide direction for determination of a significant geology/soils impact from the proposed project. For the purposes of this EIR, a significant impact would occur if the proposed project would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - i. Rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zone Map;
  - ii. Strong seismic ground shaking;
  - iii. Seismic-related ground failure, including liquefaction; or
  - iv. Landslides;
- Result in substantial soil erosion or loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code; or,
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

## 5.8.3 Environmental Impact

### 5.8.3.1 Continuing Care Retirement Community Site and RV Storage/Garden Area

#### A. Geology

According to the geotechnical evaluation, the CCRC site and RV storage/garden area are generally suitable for grading and development in accordance with the type of development proposed under the proposed project. Implementation of the project will involve mass grading activities, including the removal of all compressible surficial soils, alluvial deposits, landslide deposits found in the northeastern portion of the CCRC site, and select grading of expansive soils. The alluvial deposits found in the low-lying areas, generally in the RV storage/garden area, are characterized as having a high collapse potential. These deposits coupled with the presence of groundwater would cause a potential hazard to the support of settlement sensitive improvements. This is considered a significant impact. Implementation of Mitigation Measure GS-1 will reduce the impact of existing unsuitable soil conditions on the CCRC site to a level less than significant. Mitigation Measure GS-1 requires that all future grading and construction of the CCRC site and RV storage/garden area comply with the geotechnical recommendations contained in the Updated Geotechnical Investigation Dos Colinas Residential Development (Southern California Soil & Testing, January 29, 2009), which identifies the removal of these materials prior to construction.

**B. Seismicity**

Because the CCRC site is located in a seismically active region, the site is likely to be subject to at least one moderate to major earthquake during the design life of the structures. The nearest known active fault is the Rose Canyon Fault Zone, located approximately thirteen kilometers west of the site. Potential seismic related impacts related to the proposed project include ground shaking, soil cracking, and liquefaction. Surface rupture is not considered a potential impact, as there is no evidence of any on-site faulting. The potential impact related to ground shaking would be addressed through compliance with the UBC (UBC, 1997) as the level of risk for the CCRC site is the level of risk assumed by the UBC minimum design requirements.

Liquefaction potential has been identified in some of the alluvial soils underlying the low-lying portions, generally in the RV storage/garden area, along the northwest portion the CCRC site. However, these soils do not cause a significant risk since they are located beyond the proposed limits of development of the proposed CCRC site. There would be no structures located in this portion of the site.

**C. Landslides and Slope Stability**

The CCRC site may be susceptible to landslides and slope instability based on observations by SCS&T confirming that a landslide had previously occurred at the northeastern end of the CCRC site. Also, a majority of the site is located within Landslide Hazard Area 3, which is generally susceptible to slope instability. The Santiago Formation underlies much of the site and is generally associated with slope instability due to the low strength characteristics of its claystone and siltstone composition. As such, the potential for landslide and slope instability on the CCRC site is considered a significant impact. However, with the implementation of Mitigation Measure GS-1, this impact will be reduced to a level less than significant.

**D. Expansive Soils**

The residual soils and portions of the Santiago Formation deposits encountered at the CCRC site are moderately to highly expansive. The potential for expansive soils to affect the proposed project is considered a significant impact. However, with the implementation of Mitigation Measure GS-1, this impact will be reduced to a level less than significant.

**E. Groundwater**

Groundwater was encountered at the CCRC site, generally in the RV storage/garden area, at depths ranging from 10 to 18 feet. A concern regarding groundwater is the presence of deep, potentially compressible alluvial deposits. The alluvial deposits are unsuitable, as they do not present enough support for settlement sensitive improvements. The presence of shallow groundwater coupled with potentially compressible alluvial deposits may cause a settlement hazard to the project site. With implementation of Mitigation Measure GS-1, the potential settlement impact associated with groundwater will be reduced to a level less than significant.

**F. Flood Hazard**

The low-lying alluvial areas of the CCRC site are at a significant risk to flooding, as it is located within a 100-year flood plain. Structures would need to be raised above flood plain elevations. Please refer to EIR Section 5.12-Hydrology/Water Quality for a detailed analysis related to this issue.

**5.8.3.2 Affordable Housing Site****A. Geology**

According to the geotechnical evaluation, the affordable housing site is generally suitable for grading and development in accordance with the type of development proposed under the proposed project. A main factor affecting the affordable housing site is the presence of potentially compressible alluvium and liquefiable soil, which has the potential for settlement. This is considered a significant impact. However, with the implementation of Mitigation Measure GS-1, this impact will be reduced to a level less than significant.

**B. Seismicity**

Because the affordable housing site is located in a seismically active region, it will likely be subject to at least one moderate major earthquake during the design life of its structures. Potential seismic related impacts on the site include ground shaking and liquefaction. The potential impact related to ground shaking would be addressed through compliance with the UBC (UBC, 1997) as the level of risk for the project site is the level of risk assumed by the UBC minimum design requirements.

**C. Groundwater**

Ground water is present at depths of between about 13 and 14 feet below the existing surface. The primary constraint related to the presence of groundwater is the potential of liquefaction during a strong earthquake. As such, the potential for liquefaction on the affordable housing site is considered a significant impact because the materials underlying the site are considered liquefiable. As discussed above, with the implementation of Mitigation Measure GS-1, the potential liquefaction impact will be reduced to a level less than significant.

**5.8.4 Mitigation Measures****5.8.4.1 CCRC Site, RV Storage/Garden Area, and Affordable Housing Site**

**GS-1** Prior to approval of final engineering and grading plans for either the CCRC site, RV storage/garden area, or the affordable housing site, the City shall verify that all recommendations contained in the *Updated Geotechnical Investigation Dos Colinas Residential Development* and the *Geotechnical Investigation Dos Colinas Affordable Housing Site (Southern California Soil & Testing, 2009)* have been incorporated into all final engineering and grading plans. The City's soil engineer and engineering geologist shall review grading plans prior to finalization, to verify plan compliance with the recommendations of the report. All future grading and construction of the project site shall comply with the geotechnical recommendations contained in the geotechnical

reports. These reports identify specific measures for mitigating geotechnical conditions on the project site, and addresses grading, slope stability, foundations, concrete slabs-on-grade, and earth retaining walls.

#### 5.8.4.2 *City Standard Conditions of Approval*

In addition to the Mitigation Measures identified above, the project will be required to comply with the following City standard Conditions of Approval:

- The proposed project shall comply with the City's Excavation and Grading Ordinance (§15.16, Carlsbad Municipal Code).
- Grading information shall be submitted for review by the City with each subdivision map. Grading shall comply with grading standards and manufactured slope revegetation requirements of the City.
- The proposed project shall comply with the Dos Colinas CCRC site and the affordable housing site landscape sections and the City of Carlsbad Landscape Manual.
- All applicable federal, state, and local permits regarding drainage shall be obtained. Such permits include the National Pollution Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board.
- Erosion control measures shall be provided to the satisfaction of the City Engineer in accordance with the City's grading and erosion control requirements (Municipal Code §15.16. et. seq.). The locations of all erosion control devices shall be noted on the grading plans.
- All grading permits issued authorizing grading during the rainy season (November 16<sup>th</sup> of any year to April 14<sup>th</sup> of the following year), shall require the installation of all erosion and sedimentation control protective measures in accordance with city standards. Erosion and runoff control measures shall be designed and bonded prior to approval of grading permits by the City.
- All permanent slopes shall be planted with erosion control vegetation, drained and properly maintained to reduce erosion within 30 days of completion of grading. Erosion control and drainage devices shall be installed in compliance with the requirements of the City.
- All erosion and sedimentation control protective measures shall be maintained in good working order throughout the duration of the rainy season unless it can be demonstrated to the City Engineer that their removal at an earlier date will not result in any unnecessary erosion of or sedimentation on public or private properties.

#### 5.8.5 *Impact After Mitigation*

Implementation of Mitigation Measure GS-1 will reduce the impact to geology/soils to a level of less than significant.